



NOTES

DIPLOCOCCI: AEROBIC

MICROBE OVERVIEW

- Spherical-shaped bacteria (cocci), appear in pairs as joined cells (diplo)
- Gram-negative, aerobes/facultative anaerobes, non-motile, non-spore forming

TYPES

Moraxella catarrhalis

- Oxidase +, nitrate reduction + (characteristic)
- Part of normal respiratory flora, causes opportunistic infections
- Virulence factors
 - Beta-lactamase production → penicillin resistant
 - DNase production
- Culture
 - **Isolation specimen:** respiratory secretions, sputum
 - **Media:** blood, chocolate agar (round, opaque colonies that turn pink after 48 hours; positive “hockey puck sign”: able to slide colonies across agar with wooden stick without disruption)

Neisseria gonorrhoeae

- Facultatively intracellular
- Oxidase +, catalase +
- Fermentation
 - Glucose; differentiation from *N. meningitidis*
- Virulence factors
 - **LOS/endotoxin:** triggers inflammation; undergoes antigenic variation
 - **IgA1 protease:** cleaves IgA antibodies; aids in evasion of humoral immune response
 - **Type IV pili:** promote adhesion of bacteria to epithelium; undergo phase, antigenic variation

- **Porins (PorA, PorB):** allow movement of ions, nutrients into bacteria, promote invasion into cells
- **Opa, Opc:** promote adhesion, invasion; undergo phase, antigenic variation

▪ Culture

- **Isolation specimen:** urine, vaginal/endocervical swab, urethral swab; pharyngeal, rectal swab
- **Media:** Thayer–Martin VCN, chocolate agar

Neisseria meningitidis

- Facultatively intracellular
- Oxidase +, catalase +
- Fermentation
 - Maltose, glucose
- Present as normal non-pathogenic flora of nasopharynx in 10% of adults
- Virulence factors
 - **Capsule:** prevents phagocytosis; *N. meningitidis* subdivided into 13 serogroups based on capsular polysaccharides; A, B, C, W135, Y account for most disease cases
 - **Lipooligosaccharide (LOS)/endotoxin:** released in blebs/vesicle-like structures → sepsis, vascular necrosis, hemorrhage into surrounding tissue; levels of LOS closely correlate with prognosis
 - **IgA1 protease:** cleaves IgA antibodies; aids in evasion of humoral immune response
 - **Pili:** promote adherence of bacteria to nasopharyngeal epithelium; undergo phase, antigenic variation → protect against host immune response, vaccines
 - **Opacity proteins (Opa, Opc):** promote adhesion, invasion

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- **Factor H binding protein:**
downregulates alternative complement pathway
- **Culture**
 - **Isolation specimen:** blood, cerebrospinal fluid (CSF), petechial scrapings
 - **Media:** Thayer–Martin vancomycin, colistin, nystatin (VCN), chocolate agar

AEROBIC GRAM-NEGATIVE DIPLOCOCCI

SPECIES	HOST	MODE OF TRANSMISSION	PATHOLOGY
MORAXELLA CATARRHALIS	Humans	Respiratory droplets, fomites	Respiratory infections, otitis media
NEISSERIA GONORRHOEAE	Humans	Sexual, perinatal	Gonorrhea, disseminated gonococemia
NEISSERIA MENINGITIDIS	Humans	Respiratory droplets	Meningitis, meningococemia

MORAXELLA CATARRHALIS

osms.it/moraxella-catarrhalis

PATHOLOGY & CAUSES

- Gram-negative diplococcus → respiratory tract infections, otitis media
- Infections caused by *M. catarrhalis*
 - Respiratory tract infections (bronchitis, rhinosinusitis, laryngitis, bronchopneumonia, community-acquired bacterial pneumonia)
 - Otitis media in children < three years of age
 - Exacerbations of chronic obstructive pulmonary disease (COPD)

RISK FACTORS

- Immunocompromised individuals
- Individuals with chronic respiratory disease

(e.g. COPD, emphysema)

- Children < two years of age, elderly

COMPLICATIONS

- Rare: bacteremia, septicemia, urethritis, septic arthritis

SIGNS & SYMPTOMS

- **Acute bacterial rhinosinusitis:** fever, nasal obstruction, purulent nasal discharge, facial pain, headache
- **Otitis media:** fever, ear pain, bulging tympanic membrane
- **Exacerbations of COPD:** increased cough, sputum production/change in color, dyspnea

DIAGNOSIS

OTHER DIAGNOSTICS

- Clinical presentation
 - Sufficient for diagnosis
- Microbiologic diagnosis

TREATMENT

MEDICATIONS

- Amoxicillin-clavulanate
- Trimethoprim-sulfamethoxazole
- Third-/second-generation cephalosporins
- Macrolides (e.g. azithromycin, clarithromycin)

NEISSERIA GONORRHOEAE

osms.it/neisseria-gonorrhoeae

PATHOLOGY & CAUSES

- Gram-negative diplococcus → gonococcal disease (gonorrhea, disseminated gonococcemia, gonococcal ophthalmia neonatorum)
- Portal of entry
 - **Unprotected sex** (vaginal, oral, anal): bacteria attaches, invades genitourinary, rectal, oral epithelium via Opa, Opc, pili → **gonorrhea**
 - **Rare**: invades bloodstream → disseminated gonococcemia, **septic arthritis**
 - **Perinatal transmission**: birth canal of infected mother → gonococcal ophthalmia neonatorum

partners, sex between individuals who are biologically male (MSM), recent new sexual partner

- Low educational, socioeconomic levels
- Substance abuse
- History of gonorrhea

COMPLICATIONS

Gonorrhea

- Epididymitis, prostatitis, penile lymphangitis, urethral strictures in individuals who are biologically male; cervical gonorrhea → pelvic inflammatory disease → infertility in individuals who are biologically female

Gonococcal ophthalmia neonatorum

- Corneal scarring/perforation, blindness

TYPES

- Gonorrhea
 - Urethritis, cervicitis, proctitis, pharyngitis
- Disseminated gonococcemia
 - Result of spread, intravascular multiplication of *N. gonorrhoeae*; joints, skin (dermatitis-arthritis syndrome)
- Gonococcal ophthalmia neonatorum
 - Causes gonococcal **conjunctivitis**

RISK FACTORS

- Unprotected sex
 - Individuals with multiple sexual

SIGNS & SYMPTOMS

Gonorrhea

- Some individuals who are biologically male, most individuals who are biologically female (50–80%) asymptomatic
- **Urethritis**: dysuria, urinary urgency, purulent foul-smelling urethral discharge
- **Cervicitis**: lower abdominal discomfort, dyspareunia (pain during sexual intercourse), vaginal pruritus, purulent foul-smelling vaginal discharge

- **Proctitis:** anal pruritus, tenesmus, rectal fullness, constipation, purulent anorectal discharge, bleeding
- **Pharyngitis:** sore throat, swollen lymph nodes

Disseminated gonococemia

- Fever, chills, generalized malaise
- Polyarthralgia (multiple joint pain)
- Tenosynovitis (tendon inflammation)
- Pustular/vesiculopustular lesions on skin

Gonococcal ophthalmia neonatorum

- Purulent conjunctival discharge
- Swollen eyelids
- Conjunctival hyperemia, chemosis



Figure 68.1 A neonate with gonococcal ophthalmia neonatorum.

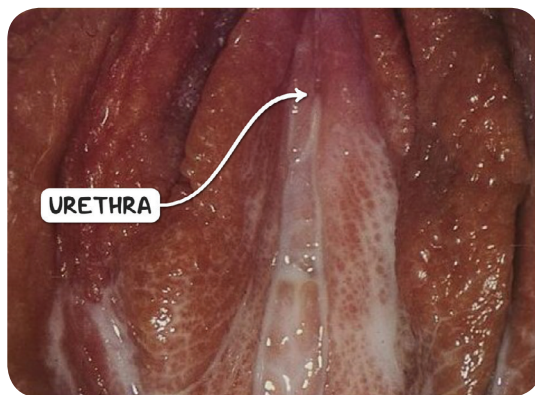


Figure 68.2 Creamy discharge emanating from the external urethral meatus is typical of genital gonorrhea infection.

DIAGNOSIS

LAB RESULTS

Blood tests

- $\geq$ two white blood cells in urethral secretions
- $\geq$ 10 white blood cells on microscopic examination of first void urine
- Disseminated gonococemia
 - Positive blood culture
 - Synovial fluid leukocyte count: increased values (50,000 cells/microL)

Gram stain

- Polymorphonuclear leukocytes with intracellular gram-negative diplococci

Nucleic acid amplification testing (NAAT)

- For initial diagnosis

TREATMENT

MEDICATIONS

- Uncomplicated gonorrhea
 - Intramuscular injections of ceftriaxone + azithromycin/doxycycline (in case of gonococcal resistance to cephalosporins, potential chlamydia regardless of chlamydial coinfection status)

OTHER INTERVENTIONS

- Prophylaxis
 - No vaccines
 - Extensive antigenic variations of bacterial components (pili, LOS, opa proteins) prevents development of immunological memory

NEISSERIA MENINGITIDIS

osms.it/neisseria-meningitidis

PATHOLOGY & CAUSES

- Gram-negative diplococcus → meningococcal disease (meningitis, meningococemia)
- Portal of entry
 - Inhalation of respiratory droplets → bacteria attaches to respiratory epithelium via Opa, Opc, pili → nasopharynx colonization → usually resolves asymptotically (carriers)
 - Invades bloodstream → meningococcal disease (rare)

TYPES

- Meningococemia
 - Result of intravascular multiplication of *N.meningitidis*; can occur alone/in conjunction with meningitis
- Meningitis
 - Most common; occurs upon spreading of bacteria to meninges during meningococemia; usually affects children, adolescents
- Fulminant meningococemia
 - AKA **Waterhouse–Friderichsen syndrome**; most severe form of meningococcal sepsis; massive bilateral hemorrhage into adrenal glands

RISK FACTORS

- Infants 6–24 months (due to immature immune system, inability to vaccinate)
- Living in close quarters (military barracks, dormitories)

COMPLICATIONS

- **Adrenal insufficiency**; disseminated intravascular coagulation (DIC); purpura fulminans (cutaneous hemorrhage, necrosis due to vascular thrombosis, DIC); acute respiratory distress syndrome (ARDS); coma, death

SIGNS & SYMPTOMS

Meningococemia

- **Petechial rash** caused by destruction of blood vessels, hemorrhage due to endotoxin release; fever, chills; joint, muscle pain

Meningitis

- Infants
 - **Early nonspecific**: irritability, vomiting, inactivity, poor feeding, temperature instability
 - **Late specific**: bulging anterior fontanelle, seizures
- Children, adolescents, adults
 - **Early nonspecific**: sudden onset of fever, headache, nausea, vomiting, myalgia
 - **Late specific**: altered mental status, lethargy, neck stiffness (nuchal rigidity), photophobia
 - **First specific symptoms of sepsis**: abnormal skin color (pallor/mottling) which can evolve from nonspecific rash to petechial to hemorrhagic over several hours; cold hands, feet; leg pain
- Signs upon physical examination
 - **Positive Kernig's sign**: inability to straighten leg when hip flexed to 90°
 - **Positive Brudzinski's sign**: flexing of neck by examiner → flexing of hips, knees

Fulminant meningococemia

- Abrupt onset
- Rapid enlargement of petechiae/ecchymoses
- Hypotension, tachycardia due to vascular collapse, **shock**

DIAGNOSIS

LAB RESULTS

- Fulminant meningococemia
 - Adrenal insufficiency signs: ↓ blood glucose, ↑ K⁺, ↓ Na⁺, adrenocorticotrophic hormone (ACTH) stimulation test (low response)
 - Thrombocytopenia due to DIC
 - Metabolic acidosis
- Meningococemia and meningitis
 - Blood culture and CSF analysis

OTHER DIAGNOSTICS

- Physical examination
 - Characteristic findings of meningitis

TREATMENT

MEDICATIONS

Prophylaxis

- Quadrivalent immunization with purified capsular polysaccharides from serogroups A, C, Y, W135 (group B not available)

Meningococcal disease

- Antibiotics
 - Third-generation cephalosporins (e.g. cefotaxime, ceftriaxone)/penicillin G
- Chloramphenicol
 - In case of beta-lactam antibiotics hypersensitivity
- Chemoprophylaxis of individuals in close contact with the infected
 - Rifampin or ciprofloxacin
- Hydrocortisone
 - For adrenal insufficiency

SURGERY

- Plastic surgery, skin grafting, amputation to treat tissue necrosis

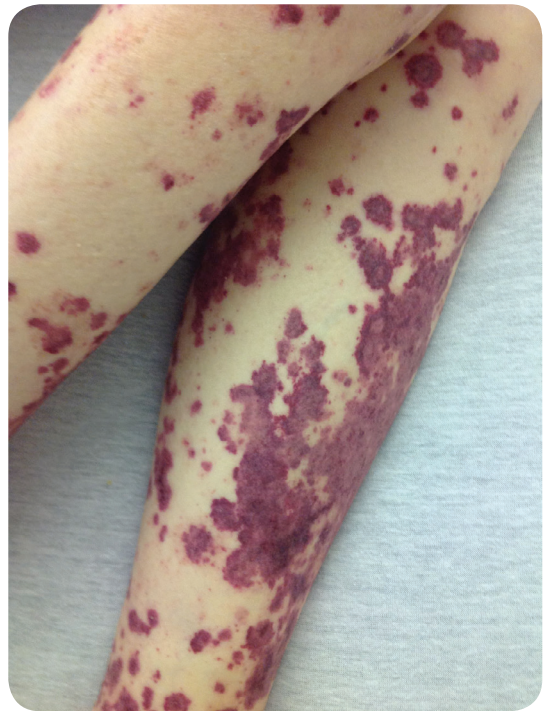


Figure 68.3 A petechial rash can be seen in the late stages of meningococcal septicemia.

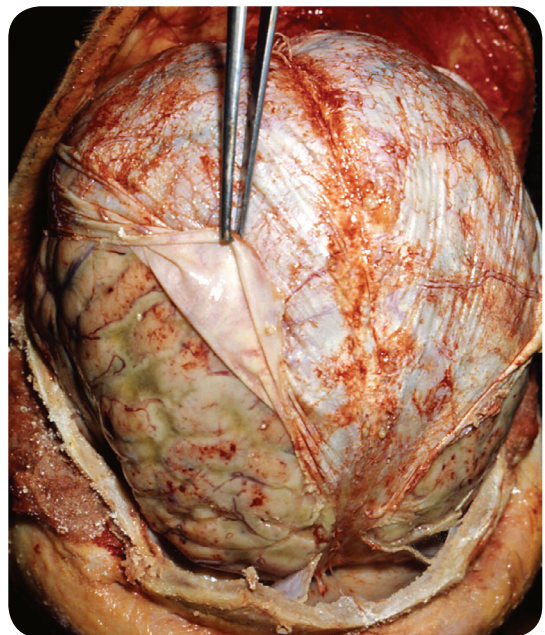


Figure 68.4 The brain of an individual at post mortem following death from bacterial meningitis. *Neisseria meningitidis* is the most common causative organism amongst adolescents and young adults.